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Film 4200 Flow Visualization
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Get Wet Report

While exploring fluid mechanics for the University of Colorado engineering/film class Flow Visualizations, I choose to examine the effects of sound waves upon a non-Newtonian fluid. The first assignment for the class entitled "Get Wet" asked students to capture an image about the flow of fluid mechanics in action. My intent was to photograph the initial moment of shift between the solid state of a non-Newtonian fluid back to its liquid manifestation. The pressure force from sound waves osculating from 60Hz to 65Hz stimulated the non-Newtonian fluid to achieve shear thickening of the fluid thus reflecting the properties of a solid.

By mixing 2 parts cornstarch with one part water I was able to end up with a non-Newtonian fluid, the suspension of the starch in water resulted in an oobleck or ooze. This mixture violates the laws of a proper Newtonian fluid: the relation between the shear rate and shear stress vary and differ disrupting a constant coefficient viscosity (Tropea). By placing this liquid within the cup of a 3in diameter speaker, separated by a layer of plastic wrap, I was able to stimulate the fluid with sound waves and vibrations. By using a free source program to generate noise, the program *ToneGen* provided the output of a pure sine wave osculating between 60Hz and 65Hz. The purpose of the oscillation was to apply a force that would solidify the non-Newtonian fluid and as it fell back onto the speaker the higher 65Hz would cause the solid-state liquid to once again ascend into the air due to the vibrations. As the form fell back into its original fluid state was the moment I wished to capture, a blend between solid and liquid; the shear thickening prosperities of this non-Newtonian fluid account for this phenomenon.

During the experimental process of capturing this image, the extreme cold weather did interfere with my liquid. After much trial and error I was able to find the perfect mixture of water and cornstarch. Additionally to prevent further vibrations to distort the non-Newtonian fluid I separated the speaker console from hardwood floors with a cloth. Lighting used was two clips lights each containing a 200-Watt bulb diffused by a single sheet of tracing paper. One light was in front and to the left of the object to create depth, the second placed above to divide foreground and background elements.

The field of view was roughly 5 inches in width. By using 3 stacked close up ring adapters attached to a 50mm prime f/1.8 I was able to achieve focus at around 25mm from the lens. Camera used was a Canon EOS Digital Rebel XT, which captured my image at 3456 x 2304 pixels set at an ISO of 400, f-stop of 8 and shutter speed of 1/1000 sec. The only digital post processing attributed to the image was minor color temperature correction regarding the white balance.

The image clearly reveals a liquid acting in an irregular fashion. The bulges and curvature of the liquid demonstrate the solid form it has taken due to the force applied to it. The image however, does not clearly show a break in form showing both liquid and solid state. Instead, the image shows the solid state of the non-Newtonian fluid, as it seems to present mechanics of a fluid. When looking at this image and the information that it is actually a liquid is perceived, one understands the phenomenon-taking place. This begs the question of whether the actual instance of when a non-Newtonian fluid shifts from solid to liquid, that the non-Newtonian fluid is physically a liquid and a solid at the same time. In the future I would like to use a high-speed camera to capture the non-Newtonian fluid throughout its trajectory.

Works Consulted

Tropea, Cameron, Alexander L. Yarin, and John F. Foss. *Springer Handbook of Experimental Fluid Mechanics*. Berlin: Springer, 2007. Print.

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